

GENDER-NEUTRAL, YET GENDERED: EXPLORING THE CANADIAN GENERAL PUBLIC'S VIEWS OF MATHEMATICS

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By investigating the general public's views, we can better understand the cultural milieu in which mathematics teaching and learning take place. This study, part of an international research project, investigated the Canadian general public's views of gender and mathematics. Using a brief survey, people on the street and in public spaces in four demographically diverse locations in the Canadian province of Ontario were asked their views on the topic. The findings suggest reasons to be both cautiously optimistic and concerned. While the most common response to the questions examined was to see no gender difference, more participants held a gendered view (typically privileging boys) than a gender-neutral view.

INTRODUCTION

Investigating the general public's views about mathematics is essential in order to garner an understanding of the social milieu in which mathematics teaching and learning occur. Unfortunately, as argued by Leder and Forgasz (2010), "attempts to measure directly the general public's views about mathematics, its teaching and its impact on careers are rare" (p. 329). While several studies exist regarding views of mathematics, these studies are often conducted with select populations, such as high school and university students (e.g., Mendick, Epstein, & Moreau, 2007; Morge, 2006). Only a few known studies have investigated this topic with the general public, and none of these were in a Canadian context. For example, research in the United Kingdom explored the general public's images and opinions of mathematics (Lim, 1999; Lim & Ernest, 1999). Overall, the most negative views of mathematics were found in the youngest age group (17-20 years of age) and in students who were not mathematics majors. Views of mathematics were mixed: Encouragingly, the majority of participants disagreed with the stereotype that mathematics is a male domain. However, the majority of the participants also agreed that mathematics is a difficult subject, only for a select few. Lim concluded that the adults' views were primarily influenced by their school mathematics experiences. More recent research (Lucas & Fugitt, 2009), conducted in the United States, explored the general public's views of mathematics education. The study's participants tended to hold traditional views, criticizing today's practices as lacking emphasis on 'the basics' and being too focused on technology. Overall, mathematics was seen by the participants as being very important to success in both postsecondary education and future careers.

Due to concerns about a lack of research in this domain, Leder and Forgasz initiated research in Australia that investigated the general public's views of mathematics, with

a particular focus on gender and mathematics (reported in such publications as Forgasz & Leder, 2011; Forgasz, Leder, & Gómez-Chacón, 2012; and Leder & Forgasz, 2010, 2011). Using a brief survey, initially conducted on the street and later via Facebook, Leder and Forgasz gathered data from both Australian and international participants. In order to expand the research internationally, a team of researchers was assembled to collect street-level data in a variety of countries. The research reported in this paper addresses the data collected in Canada for this larger, international research project.

Context

The data collection for the Canadian sample took place in the province of Ontario, which is located in central Canada and contains nearly 40% of the country's population (Statistics Canada, 2010a). In Canada, education falls under the purview of individual provinces and territories (i.e., no national curriculum exists). Ontario's mathematics curriculum (Ontario Ministry of Education, 2005a, 2005b, 2007) addresses a wide variety of mathematical topics in each grade level, and emphasis is placed on diversity in both teaching practices and assessment types. The use of mathematical tools is encouraged, both in class and on provincial large-scale assessments. Fundamentally, the Ontario Mathematics Curriculum is based on the belief that "all students can learn mathematics and deserve the opportunity to do so" (2005a, p. 3).

Since the 2003/2004 school year, Ontario students have been required to participate in large-scale provincial assessments of mathematics in Grades 3, 6, and 9. These assessments are created and conducted by the Education Quality and Accountability Office (EQAO). The EQAO assessments involve a variety of question types and address the provincial curriculum. My analysis of five years of EQAO data (Hall, 2012) showed that no statistically significant gender differences existed at any grade level in terms of mathematics achievement. In contrast, as demonstrated by data from the questionnaires that accompany the assessments, gender differences existed with regard to affective factors. Namely, across all grade levels and across the five years of data examined, a statistically significantly higher percentage of boys, compared to girls, reported liking mathematics and being good at it.

In Ontario, students are required to take three mathematics credits during high school. At the Grade 12 level, when most students have completed their required mathematics courses, boys have a higher proportion of mathematics courses in their timetables than do girls. Additionally, boys are the majority of students in five of the six Grade 12 mathematics courses offered (Hall, 2012). These gender differences persist at the university level, where women are the minority in mathematical fields from the bachelor's to doctoral degree level. Notably, the proportion of women in mathematical fields of study at the bachelor's and master's degree levels has been declining since the early 1990s (Statistics Canada, 2010b).

THEORETICAL FRAMEWORK

This study was guided by a social constructivist and feminist epistemological stance, in which gender is viewed as being socially constructed, as well as historically and culturally situated. I align with Howard and Hollander's (1997) definition of gender as "the culturally determined behaviors and personality characteristics that are associated with, but not determined by, biological sex" (p. 11, as cited in Glasser & Smith, 2008, p. 346). In this definition, the roles that the broader society and culture play in policing behaviours presumed to be 'gender-appropriate' are highlighted, which is particularly relevant in mathematics, a field historically viewed as a male domain. I view both gender and sex as social constructions that fall on a spectrum, rather than into binary categories. That said, I support the lead researchers' decision to offer 'boys' and 'girls' as responses – both in terms of a pragmatic decision and in terms of reflecting current society, in which binaried representations and categorizations are the norm.

METHODOLOGY

As this research is part of a larger, international project instigated by Gilah Leder and Helen Forgasz of Australia, the data collection instrument and methods of data collection followed the guidance of the principal investigators.

Data Collection Instrument

Data were collected using a survey comprised of 14 questions that addressed the research topic (i.e., views of gender and mathematics) and the participant's mathematical experiences. Namely, two questions addressed the participant's school mathematics experiences, while the other 12 questions addressed the research topic. Specifically, three of these questions generally sought the participant's views on mathematics while nine addressed gender issues, both with regard to mathematics and science/technology more generally. In addition to these survey questions, demographic information about the participant's gender, age (under 20, 20 to 39, 40 to 59, and 60 and older), and home language (strictly English or another language) was collected.

Data Collection and Participants

Data were collected in the Canadian province of Ontario between December of 2012 and August of 2013. Four locations were selected based on their varied demographic make-up, herein referred to as Rochester (rural, southwestern Ontario, population of 3,000), Thomasville (town, central Ontario, population of 25,000), Upton (urban, eastern Ontario, population of 900,000), and Smithburg (suburb, eastern Ontario, population of 110,000). Data collection took place in grocery stores in Rochester and Smithburg, in a community centre in Thomasville, and on a downtown street in Upton. In each location, permission to conduct the research was garnered by the appropriate individuals (e.g., store managers), in addition to the Research Ethics Board permission granted by the Australian and Canadian universities associated with the research. In Thomasville, the initial data collection site, I collected the data by myself, which resulted in an inefficient process (seven hours to collect approximately 50 surveys).

For the other three sites, I was assisted by a colleague in order to make the data collection process more efficient; in each instance, the requisite number of surveys was collected in two hours. In each location, data collection occurred on a weekend day or holiday, in hopes of maximizing the number of passersby.

In each instance, I would approach a passerby, introduce myself, and ask if they would be willing to take part in a brief survey. Participants were then asked if they agreed to be audiotaped; if not, answers were recorded on a hard copy of the survey. Prior to being asked the gender-related questions, the participants were informed that, although the questions were worded in a binary manner (i.e., girls or boys), they were welcome to answer as they wished (e.g., 'They are equal'). If participants inquired further about the research project, a handout was provided with more information.

In total, 204 people participated in this project: 52 from Rochester, 53 from Thomasville, 49 from Upton, and 50 from Smithburg. In each location, more women than men took part, although the participants were more gender-balanced in Upton and Smithburg (55.1% and 52.0% women, respectively) than in Rochester and Thomasville (67.3% and 62.3% women, respectively). Overall, 59.3% of the participants were women. The age distribution of the participants is shown in Table 1, with percentages applying to each row.

	Age Category			
	Under 20	20 to 39	40 to 59	60 and older
Rochester	4 7.7%	15 28.8%	13 25.0%	20 38.5%
Thomasville	0 0.0%	26 49.1%	11 20.8%	16 30.2%
Upton	0 0.0%	33 67.3%	9 18.4%	7 14.3%
Smithburg	0 0.0%	13 26.0%	20 18.4%	17 34.0%
Total	4 2.0%	87 42.6%	53 26.0%	60 29.4%

Table 1: Participants, by age category

Data Analysis

Using the audio or written recordings, the participants' responses to the questions were coded using categories (e.g., 'boys', 'girls', 'same', 'don't know', 'depends') provided by the lead researchers (to allow for international comparisons). These data were analyzed using descriptive statistics (e.g., percentages). If participants provided further explanation for their responses, these comments were transcribed and analyzed using emergent coding. That is, the responses for each question were examined to obtain a sense of the data, and then categories were created and used to code the responses. Due to the space constraints of this paper, results will be presented for the dataset as a

whole. During the conference, additional analysis with regard to the age and gender of the participants will be presented.

FINDINGS

For the purposes of this paper, I focus on the two questions about the participants' school experiences, in order to provide a clearer profile of those who took part in the research, and the five questions that specifically related to gender and mathematics. Findings are presented for each question in the following sections. Responses that were coded as 'don't know' or 'depends' are combined as 'unsure/ambivalent'.

When you were at school, did you like learning mathematics?

Just over half of the participants (54.4%) reported that they enjoyed learning mathematics while they were in school, compared to 33.3% who reported disliking mathematics. Only 12.3% of the respondents reported feeling ambivalent toward mathematics. Unsurprisingly, the explanations provided for positive or negative feelings toward mathematics often related to how strong or weak the participants felt they were in mathematics. Other reasons provided for liking mathematics included finding the subject interesting and real-world applicable, as well as appreciating the logic, order, and 'black and white' nature (i.e., only one right answer) of mathematics. Participants who disliked mathematics described it as boring, reported having poor teachers, and described themselves as 'language people'.

Were you good at mathematics?

As noted, reports of liking mathematics were often linked to reports of being good at mathematics. It follows that a similar proportion of participants, 52.9%, reported being good at mathematics. However, participants who felt they were not good or average at mathematics were more evenly distributed (27.0% and 20.1%, respectively) than the 'no' or 'ambivalent' responses to the prior question. Explanations for being good at mathematics primarily related to school grades, although a few participants provided other evidence, such as working in a mathematics-focused field, being in gifted classes, and understanding mathematics quickly.

Who are better at mathematics, girls or boys?

Encouragingly, the most common response (37.3%) was that there were no gender differences. However, this response was only slightly more common than believing that boys are better at mathematics (31.9%). Although a substantial proportion of participants reported that girls are better at mathematics (20.6%), these responses were only two-thirds the number of those who selected boys. Therefore, over half of the participants held some sort of gendered stance with regard to mathematics. Few participants reported being unsure or ambivalent toward this question (10.3%). Explanations for girls' mathematical superiority often related to girls being stronger students overall, whereas explanations for boys' mathematical superiority tended to relate to innate ability ('mathematical nature'). Related, the notion of girls being better at language arts and boys being better at mathematics was discussed.

Do you think this has changed over time?

Participants' views were quite mixed (40.2% agreed and 44.6% disagreed), which may perhaps be indicative of different interpretations of the question. Some participants' explanations appeared to indicate that they thought the question referred to ability, whereas others' explanations indicated understanding the question as referring to achievement. In the former cases, participants would explain that girls and boys have always been equally capable of doing mathematics, but that societal factors may have held girls back (e.g., sexist teachers). In the latter cases, participants stated that boys used to do better at mathematics, but that girls now do equally as well (or, in some cases, better), since they have more opportunities. Nearly one-sixth (15.2%) of the participants reported being unsure or ambivalent about this question.

Who do parents believe are better at mathematics, girls or boys?

While the participants' views of parents' views of gender and mathematics were quite mixed, the most common response was to believe that parents thought that boys were better than girls at mathematics (30.9%). These participants argued that parents held these views because they believed the stereotypes about gender and mathematics. Nearly as many participants (27.9%) argued that parents held gender-neutral views of their children and mathematics. As with the previous question, the least common view was that parents believed that girls were better at mathematics (21.1%). Similar to the previous question, one-fifth of the participants reported being unsure or ambivalent about this question (20.1%). These participants often explained that they either did not have children or that their children were adults.

Who do teachers believe are better at mathematics, girls or boys?

In contrast to views of parents, the most common view of teachers was that they held gender-neutral views of their students and mathematics (33.8%). Participants explained that teachers would have more knowledge about this topic than the 'average person', plus they would have exposure to many children doing mathematics, so would form a less biased view than parents (who may base their opinions solely on their own children). Perceptions of teachers holding gendered views were fairly equally distributed: 18.6% of participants reported boys, compared to 20.1% reporting girls. Explanations provided were similar to those discussed with regard to being better at mathematics in general. A large proportion of the participants (27.5%) reported being unsure about teachers' feelings. These participants typically explained that they had no contact with teachers at the present time, either because they did not have school-aged children or because they did not know any teachers personally.

Is it more important for girls or boys to study mathematics?

Of all the questions regarding gender and mathematics, this question had the most consistency in the participants' responses: 94.6% of the participants argued that it was equally important for boys and girls to study mathematics. Only 2.5% of participants reported a gendered stance (0.5% for girls; 2.0% for boys). Additionally, only 3.0%

reported being unsure or ambivalent toward this question. The overwhelmingly most common explanation provided was that everyone needs to know mathematics – for school, everyday life, and future occupations. Indeed, many participants were incredulous that the survey would even include such a question.

CONCLUDING REMARKS

The data from over 200 participants from the Canadian province of Ontario suggest that gendered views of mathematics (and of others' views of mathematics) tend to be the norm. Although 'no difference' was typically the category with the highest proportion of responses, the combination of 'girls' and 'boys' categories (i.e., the gendered responses) was almost always a higher proportion. The only question for which the majority of participants held a gender-neutral view (rather than a 'boys' or 'girls' view) addressed studying mathematics. For the questions regarding superiority in mathematics, more participants held a gendered view (either boys or girls) than a gender neutral view. In most cases involving gendered views, more participants selected boys than girls, indicating a more favourable view of boys and mathematics. This finding suggests that gender stereotypes regarding mathematics persist, even in a very gender-neutral society like Ontario, wherein equity is inscribed in the mathematics curriculum. Similar findings were found in the culturally-similar country of Australia: While nearly all participants held gender-neutral views with regard to studying mathematics and 'no difference' tended to be the most common response, the greatest proportion of participants held gendered views regarding being 'better' at mathematics, with boys being selected more often than girls as a response (Leder & Forgasz, 2010).

The findings from this Canadian research, while somewhat encouraging, should also raise concerns for those involved in mathematics education. Since the majority of the adults surveyed tended to hold gendered views (with more of these gendered views favourable toward boys than girls), these messages are arguably being disseminated to young people, particularly by their parents. In another research project (Hall, 2013), I found that children's views of mathematics are indeed impacted by their parents' views of the subject matter. Thus, targeting parents' understandings of gender and mathematics, by both the educational system and the media (which, in both cases, mathematics education researchers can play a key role), should be a focus.

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